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Test Communication Management Unit

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Abstract:

This report describes the software architectural design and user manual of the Test Communication Management Unit.

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Test Communication Management Unit

by
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Summary

This report describes the software architectural design and user manual of the Test Communication Management Unit

CONTENTS

1. ACRONYMS AND ABBREVIATIONS DEFINITIONS 1

2. PURPOSE AND SCOPE 2

3. MAJOR FEATURES OF THE TEST COMMUNICATION MANAGEMENT UNIT 2

4. GENERAL OVERVIEW 3

5. MESSAGES FORMAT 4

5.1. INTRODUCTION 4
5.2. MSP MESSAGE FORMAT 4
5.3. BROADCAST MESSAGE FORMAT 4
5.4. GICB MESSAGE FORMAT 4

6. TCMU SOFTWARE ARCHITECTURAL DESIGN 5

7. TEST COMMUNICATION MANAGEMENT UNIT USER MANUAL 7

7.1. INTRODUCTION 7
7.2. INSTALLING THE TEST COMMUNICATION MANAGEMENT UNIT 7
7.3. RUNNING THE TEST COMMUNICATION MANAGEMENT UNIT 8
7.4. TEST COMMUNICATION MANAGEMENT UNIT OPERATING INSTRUCTIONS 9
7.4.1. GICB Editor 9
7.4.2. Main User Interface 13
7.4.2.1. Broadcast Messages 13
7.4.2.2. MSP Messages 13
7.4.2.2.1. Load Message or File 13
7.4.2.2.2. Load File 13
7.4.2.2.3. Load Message 13
7.4.2.2.4. Receive File 14
7.4.2.2.5. Quit TCMU 14
7.4.3. Final Considerations 14

8. TEST PROCEDURES AND FUTURE DEVELOPMENTS 15

9. REFERENCES 16

APPENDIX 1

PHOTO N° 1

PHOTO N° 2

1. Acronyms and Abbreviations Definitions

AAC	Advanced ARINC Card
ADLP	Aircraft Data Link Processor Unit
ADS	Automatic Dependent Surveillance
ATN	Aeronautical Telecommunication Network
BDS	Binary Data Store. Register number with 56 bit in the Mode S transponder.
ELM	Extended Length Message
GICB	Ground Initiated Comm-B Messages
GPFT	General Purpose File Transfer Protocol
ICAO	International Civil Aviation Organisation
LDU	Link Data Unit
MA	Comm-A message, 56 bit field
MC	Comm-C message, 80 bit field
MOPS	Minimal Operation Requirements Document
MSP	Mode S Specific Protocol
SLM	Short Length Message
STNA	Service Technique de la Navigation Aérienne
TRT	Télécommunications Radio-électriques et Téléphoniques
TUB	Technische Universität Braunschweig
XPDR	Mode S Transponder

2. Purpose and Scope

The purpose of this document is to provide an overall description of the software architectural design and user manual of the Test Communication Management Unit developed at the EUROCONTROL Experimental Centre.

3. Major Features of the Test Communication Management Unit

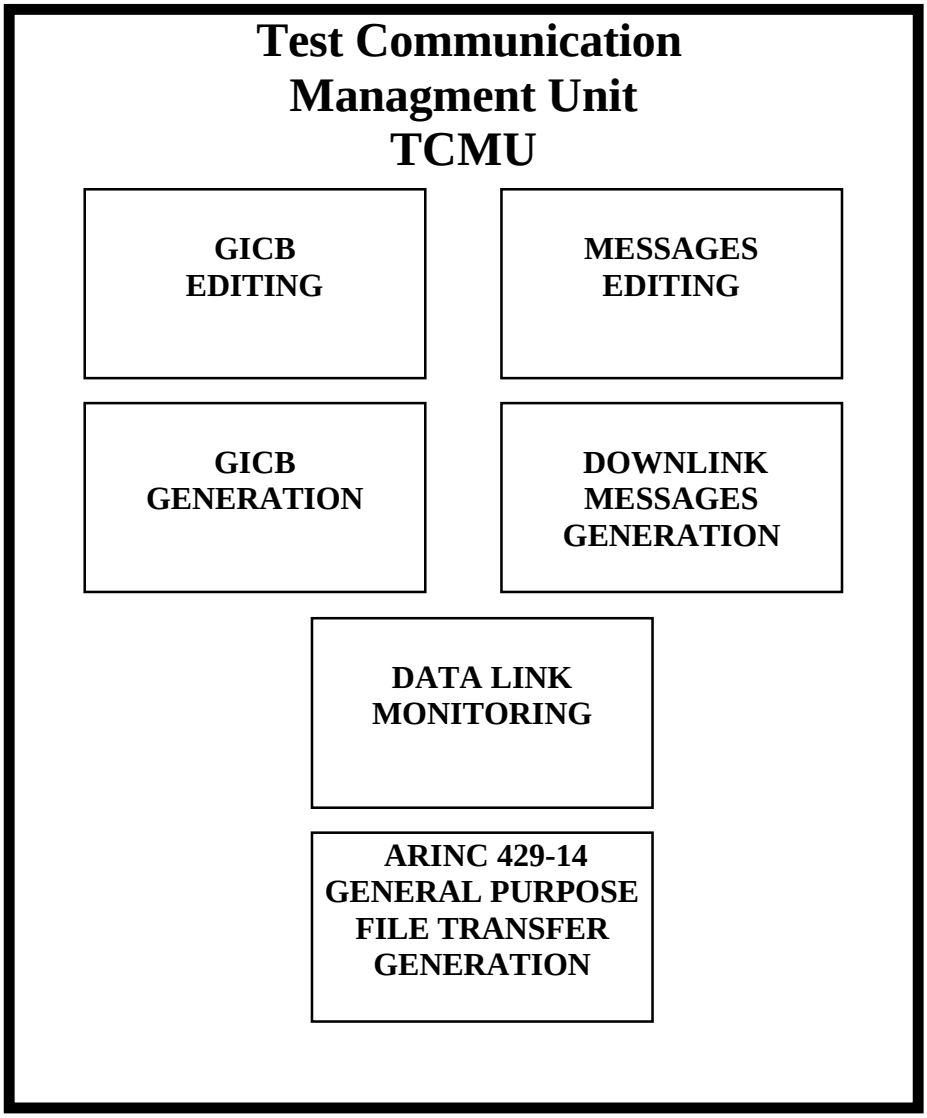


Figure no. 1 - Major features of the Test Communication Management Unit

The Test Communication Management Unit is a software device Installed in a HP-UX workstation and using an Advanced ARINC Card version 2 (EEC Note No. 17/94).

This software enables the user to generate or monitor Mode S data link messages.

The transmission of MSP, Broadcast and GICB messages, is supported by the AAC using an ARINC 429-14 GPFT Protocol.

4. General Overview

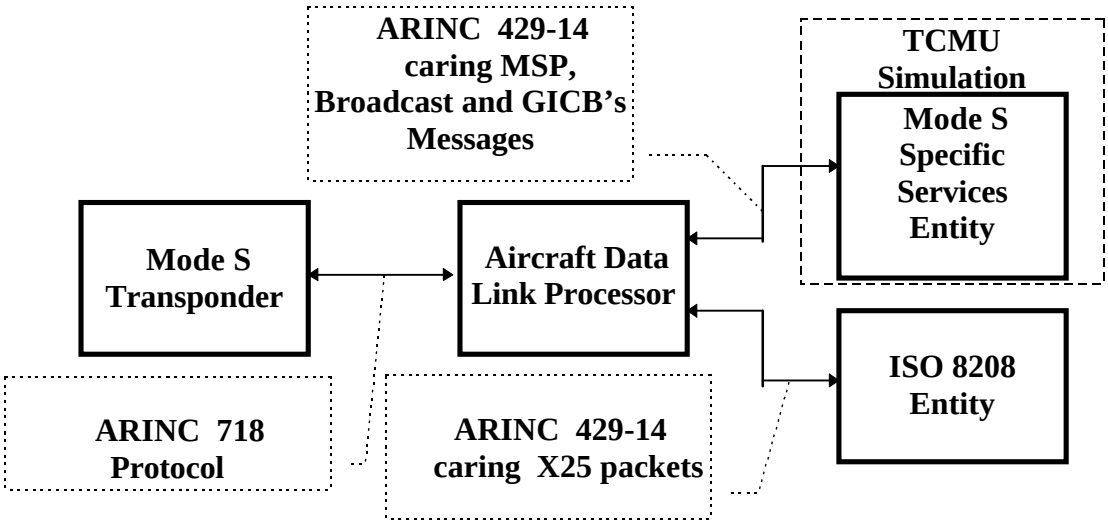

ARINC 429-14 caring MSP, Broadcast and GICB's Messages
TCMU Simulation
Mode S Specific Services Entity
Mode S Transponder
Aircraft Data Link Processor
ISO 8208 Entity
ARINC 718 Protocol
ARINC 429-14 caring X25 packets

Figure no. 2 - General overview of an airborne ADLP environment

The figure shown above gives a general overview of the airborne Aircraft Data Link Processor environment.

With the evolution of the new generation of Mode S equipment and having in mind the implementation of the future ATN, the need to have low cost tools able to evaluate the harmonisation of communication protocols between different types of AVIONICS equipment set, became apparent.

The software feature presented in this note, the TCMU, is able to simulate a Mode S Specific Services entity as shown above in an experimental and test environment.

Installed in HP-UX workstation connected to a standard network environment, this software offers the possibility of being remote controlled and accessed from anywhere.

Using the ARINC 429-14 GPFT which corresponds to the ISO level 2 link layer, this software is open to the encapsulation of any communication protocol running over it.

An immediate application of these principles and behaviours is the transport of MSP, Broadcast and GICB messages.

The format of these messages is defined in the next chapter.

5. Messages Format

5.1. Introduction

The format defined below correspond to the one used by the Rockwell & Collins ADLP.

5.2. MSP Message Format

The format of the MSP message transmitted between the ADLP and the TCMU for uplink and downlink shall be as follows:

Byte 1 ⇒ MSP Message Type, always 13 (hexadecimal).

" 2 ⇒ MSP Channel Number, defined in the ADLP MOPS document, table 2-6.

" 3 ⇒ MSP Length, number of MSP data bytes that follows.

" 4..n ⇒ MSP Data.

5.3. Broadcast Message Format

The format for a Broadcast message transmitted between the ADLP and the TCMU shall be as follows:

Byte 1 ⇒ Broadcast Message Type, always 11 (hexadecimal).

" 2 ⇒ Broadcast Identifier, defined in the ADLP MOPS document, table 2-7.

" 3..8 ⇒ Broadcast Data.

5.4. GICB Message Format

The format for a GICB message transmitted to the ADLP shall be as follows:

Byte 1 ⇒ GICB Message Type, always 10 (hexadecimal).

" 2 ⇒ GICB Register Number, defined in the ADLP MOPS document, table 2-5.

" 3..9 ⇒ GICB Data.

An example of a GICB message for the register 40 can be found in appendix No. 1.

6. TCMU Software Architectural Design

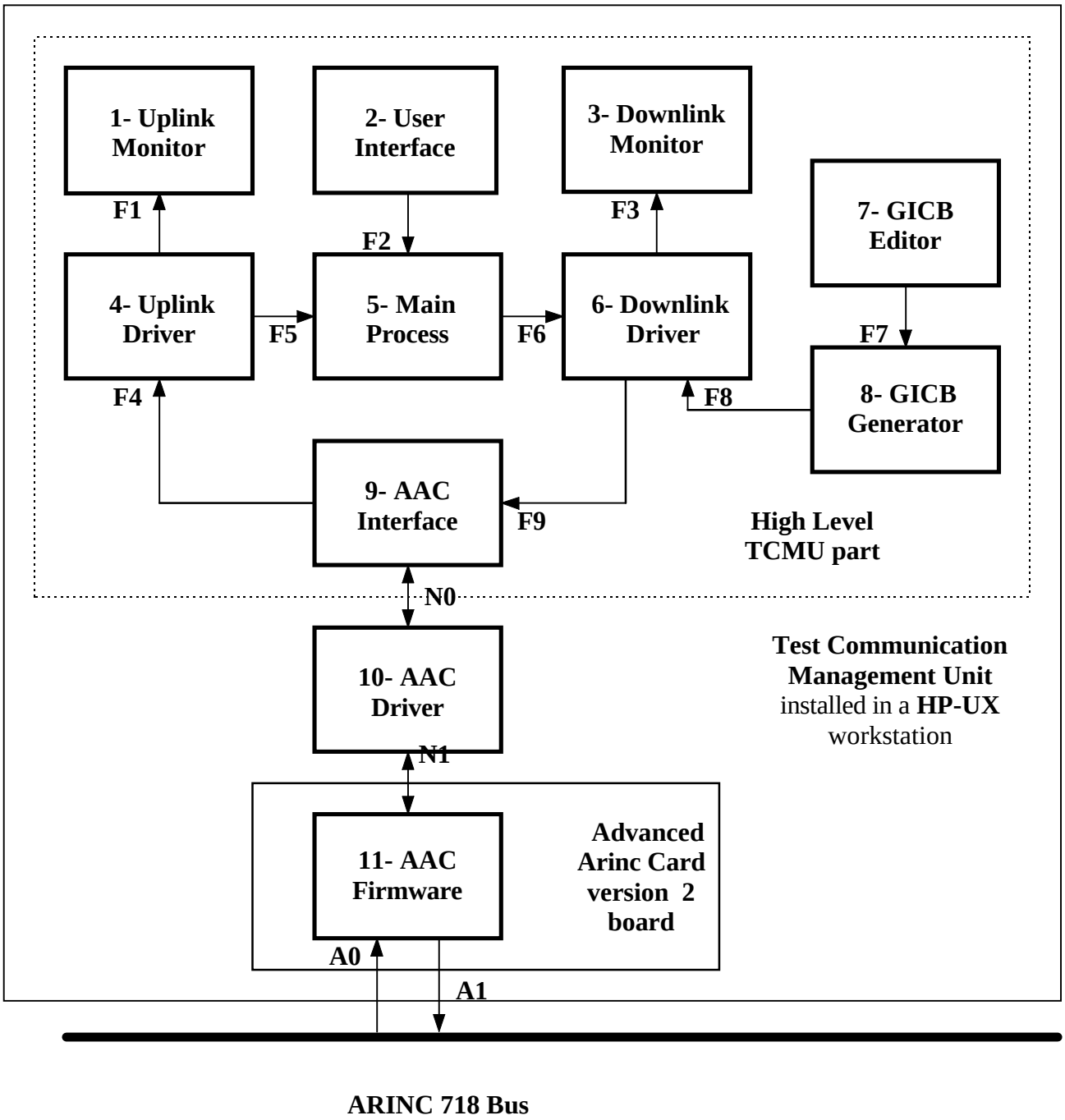


Figure no. 3 - TCMU software architectural design

Notes :

1. F1 to F9 are System V IPC facilities, shared memory and semaphores
2. N0 and N1 are HP-UX kernel data transfer blocks
3. A0 and A1 are ARINC channels

As shown in figure No. 2, the TCMU is basically a data link processor. This software device can be split in three parts, the high level running in the HP-UX workstation, the HP-UX driver to access the AAC and finally, the low level software running in the card, the firmware.

The high level part performs the following tasks: AAC driver interface, user interfacing, MSP, GICBs and Broadcast messages generation and finally data link monitoring. This part was written in HP-UX C programming language.

Since the application is running in a HP-UX operating system it became necessary to implement a HP-UX driver to access the card.

This driver developed by Hewlett-Packard France can be configured accordingly with the chosen AAC interrupt level or memory address.
The configuration manual of this driver is not included in this document but can be supplied by EUROCONTROL.

Finally, the low level software running in the card, the firmware, implementing the high speed ARINC Williamsbourg 429-14 Bit Oriented Protocol.
The firmware architectural design and functional description are not included in this document but can be supplied by EUROCONTROL.

7. Test Communication Management Unit User Manual

7.1. Introduction

The purpose of this chapter is to give a general overview of how a user can install and implement this software package and, at the same time, to describe how to use all the TCMU software facilities.

7.2. Installing the Test Communication Management Unit

The TCMU software is archived in the file “tcmu.tar”. In the subdirectory TCMU use the command “tar -xvf tcmu.tar” to extract all related files. In the subdirectory TCMU /tcmu.bin execute the file “make0” to compile the source files which are located in the subdirectory TCMU/tcmu.src. After successful compiling the following executable files should be found.

“tcmumain"	Main process
*“tcmuaac"	AAC interface
*“tcmup"	Uplink driver.
“tcmudown"	Downlink driver
*“tcmudownmon"	Downlink monitor
*“tcmupmon"	Uplink monitor
“tcmuser"	User interface.
“tcmu"	File script to start running the TCMU
*“tcmugigen"	GICB generation file
“tcmugiedit"	GICB editor
“gicb.dat”	Default file with AVIONICS data
“sem.ftok.tcmu”	IPC semaphores facilities reference file
“shm.ftok.tcmu”	IPC shared memory facilities reference file .
“gpftcmu.exe"	AAC firmware

* Note : All screen output messages are recorded in a file with extension “.rec”.

The complete list of files necessary to run the TCMU should also include the HP-UX driver necessary to establish the connection between the AAC firmware and this software application.

7.3. Running the Test Communication Management Unit

To start running the user should type "tcmu". This script file before activating the 9 processes mentioned below asks the name of the GICB file used.

If nothing is written, after having pressed <ENTER> key, the file “gicb.dat” is read by default, see ***Photo1***. Each of the 9 processes activated are running in a single « hpterm » visual window, see ***Photo 2***.

TCMU_DOWNLINK_DRIVER	⇒	“tcmudown”
TCMU_UPLINK_DRIVER	⇒	“tcmup”
TCMU_DOWNLINK_MONITOR	⇒	“tcmudownmon”
TCMU_UPLINK_MONITOR	⇒	“tcmupmon”
TCMU_AAC_INTERFACE	⇒	“tcmuaac”
TCMU_USER_INTERFACE	⇒	“tcmuser”
TCMU_MAIN_PROCESS	⇒	“tcmumain”
TCMU_GICB_GENERATOR	⇒	“tcmugigen”
TCMU_GICB_EDITOR	⇒	“tcmugiedit”

Use the mouse to select the correspondent « hpterm » window. How to operate with all processes will be described in the next chapter.

7.4. Test Communication Management Unit Operating Instructions

7.4.1. GICB Editor

The GICB editor is an on line editor of simulated AVIONICS data. Data can be introduced having as parameters the BDS number, the resolution and the minimum and maximum value accepted.

BDS	DATA	RANGE	RESOLUTION
5	Airborne Format	0, 7..14	----------
	Surveillance Status	0..3	----------
	Turn Indicator Bit	0..1	----------
	Barometric Altitude	50,175 ft	25 ft
	Time Bit	0..1	----------
	Latitude	± 90°	0.0007 °
	Longitude	± 180°	0.0014 °
6	Type	0, 5,6	----------
	Movement MOV_SPM	0..128	----------
	Track	± 180°	2.816 °
	Barometric Altitude	50,175 ft	25 ft
	Time Bit	0..1	----------
	Latitude	± 90°	0.0007 °
	Longitude	± 180°	0.0014 °
40	Flight Path Angle	± 180°	0.18°
	Flight Path Acceleration	4 g	0.001 g
	Corrected Angle of Attack	± 180°	0.044°
	Barometric Correction Altitude	131,072 ft	8 ft
50	Mach Number	4.096 Mach	0.001 Mach
	Computed Air Speed	1,024 Kt	0.5 Kt
	Track Angle True	± 180°	0.044°
	Track Angle Magnetic	± 180°	0.044°

BDS	DATA	RANGE	RESOLUTION
60	Track Angle Magnetic Ground Speed Altitude Rate Static Air Temperature	± 180° 2,048 Kt ± 16,384 ft/min ± 512°	0.044° 0.5 Kt 64 ft/min 0.5°
70	Selected Altitude Range Selected Heading Status Word 1 Status Word 2	65,536 ft ± 180° 270 271	16 ft 0.8° Binary Input Binary Input
80	Selected Airspeed Selected Altitude Rate Selected Altitude Status Word 1	512 Kt 16,384 ft/min 45,536 ft Label 270	0.25 Kt 16 ft/min 16 ft Binary Input
90	Selected Mach Number Selected Altitude Rate Selected Altitude Status Word 2	4.096 Mach 16,834 ft/min 65,536 ft Label 271	0.002 Mach 16 ft/min 16 ft Binary Input
AO	Cross Track Error Vertical Deviation Acceleration	128 nm 2,048 ft ± 1 g	0.004 nm 1 ft 0.016 g
BO	Computer Airspeed True Airspeed Mach Heading (magnetic)	1,024 Kt 2,048 Kt 4.096 Mach ± 180°	0.25 Kt 0.5 Kt 0.00025 Mach 0,18°
21	Magnetic Heading True Air Speed Static Air Temperature Normal Acceleration	± 180° 2,048 Kt ± 512°C ± 1 g	0.18° 0.5 Kt 0.5° C 0.016 g
31	Bearing to Waypoint Time to Go Distance to go	± 180° 399.9 min 399.9 nm	0.18° 0.1 min 0.1 nm

BDS	DATA	RANGE	RESOLUTION
41	Active Waypoint 1 Active Waypoint 2 Desired Track	3 characters 3 characters ± 180°	ISO 5 ISO 5 0.18°
51	Latitude Longitude Altitude	± 90° ± 180° 131,072 ft	0.00035° 0.0007° 8 ft
61	G.M.T. Flight Number	HHMMSS xxxx	
71	Roll Angle Altitude Rate Wind Speed Wind Angle	± 90° ± 8,192 ft/min 256 Kt ± 180°	0,35° 128 ft/min 1 Kt 0.703°
CO	Radio Height Average Static Pressure Altitude	8,192 ft 1,024 mb 131,072 ft	1 ft 0.25 mb 1 ft
24	Centre of Gravity Gross Weight	99.9 % 131,072 lbs	0.1 % 160 lbs

BDS	DATA	RANGE	RESOLUTION
17	N1 Actual Engine # 1 Fuel Flow Engine # 1 Total Air Temperature Static Air Temperature	256 % rpm 32,768 lb/hr ± 512°C ± 512°C	0.13 % rpm 8 lb/hr 0.5°C 0.5°C
27	N1 Actual Engine # 2 Fuel Flow Engine # 2 Total Air Temperature Static Air Temperature	256 % rpm 32,768 lb/hr ± 512°C ± 512°C	0.13 % rpm 8 lb/hr 0.5°C 0.5°C
37	N1 Actual Engine # 3 Fuel Flow Engine # 3 Total Air Temperature Static Air Temperature	256 % rpm 32,768 lb/hr ± 512°C ± 512°C	0.13 % rpm 8 lb/hr 0.5°C 0.5°C
47	N1 Actual Engine # 4 Fuel Flow Engine # 4 Total Air Temperature Static Air Temperature	256 % rpm 32,768 lb/hr ± 512°C ± 512°C	0.13 % rpm 8 lb/hr 0.5°C 0.5°C
1A	Aircraft Identification Aircraft Identification Aircraft Identification	2 char. ISO5 2 char. ISO5 2 char. ISO5	Label 233 Label 234 Label 235
1B	Aircraft Identification Aircraft identification	2 char. ISO5 2 char. ISO5	Label 236 Label 237

7.4.2. Main User Interface

This process allows the user to terminate a TCMU session and to edit or send downlink MSP or Broadcast messages.

7.4.2.1. Broadcast Messages

To chose this option type <0>. Confirm it by typing <y>, <Y> or <ENTER>.
Type <Y>, <y> or <ENTER> to confirm your edition and <N> or <n> to cancel it.

For the complete editing of your Broadcast message fill the following displayed table. Use decimal characters and type <ENTER> to finish.
.

BROADCAST MESSAGE	
BROADCAST IDENTIFIER	

7.4.2.2. MSP Messages

7.4.2.2.1. Load Message or File

To chose this option type <1>. Confirm it by typing <y>, <Y> or <ENTER>.

7.4.2.2.2. Load File

To chose this option type <1>. Confirm it by typing <y>, <Y> or <ENTER>.
Type your file name and type <ENTER> to finish. Confirm it by typing <y>, <Y> or <ENTER>. If your file does not exist the following message will be printed in the screen:

" Your file does not exist. "

To complete your edition of fill the following displayed table. Use decimal numbers and type <ENTER> to finish.

MSP PACKET	
MSP CHANNEL NUMBER	

Type <Y>, <y> or <ENTER> to confirm your edition and <N> or <n> to cancel it.

7.4.2.2.3. Load Message

To chose this option type <2>. Confirm it by typing <y>, <Y> or <ENTER>.

Type your message with a maximum of 644 characters and type <ENTER> to finish. 644 Characters corresponds to a single LDU.

Type <Y>, <y> or <ENTER> to confirm your edition and <N> or <n> to cancel it.

For the complete editing of your MSP message fill the following displayed table. Use decimal numbers and type <ENTER> to finish.

MSP PACKET	
MSP CHANNEL NUMBER	

Type <Y>, <y> or <ENTER> to confirm your edition and <N> or <n> to cancel it.

7.4.2.2.4. Receive File

To chose this option type <2>. Confirm it by typing <y>, <Y> or <ENTER>.
Type your file name and type <ENTER> to finish. Confirm it by typing <y>, <Y> or <ENTER>.
If your file already exist the following message will be printed in the screen:

" Your file already exist, do you want to overwrite"

If you want to overwrite type <y>, <Y> or <ENTER>, otherwise type <n> or <N>.
To stop recording type <ENTER>.

7.4.2.2.5. Quit TCMU

To quit and close all processes type <q> or <Q>. Confirm it by typing <y>, <Y> or <ENTER>. To cancel it type <N> or <n> .

7.4.3. Final Considerations

All the other processes do not require any user operation.

8. Test Procedures and Future Developments

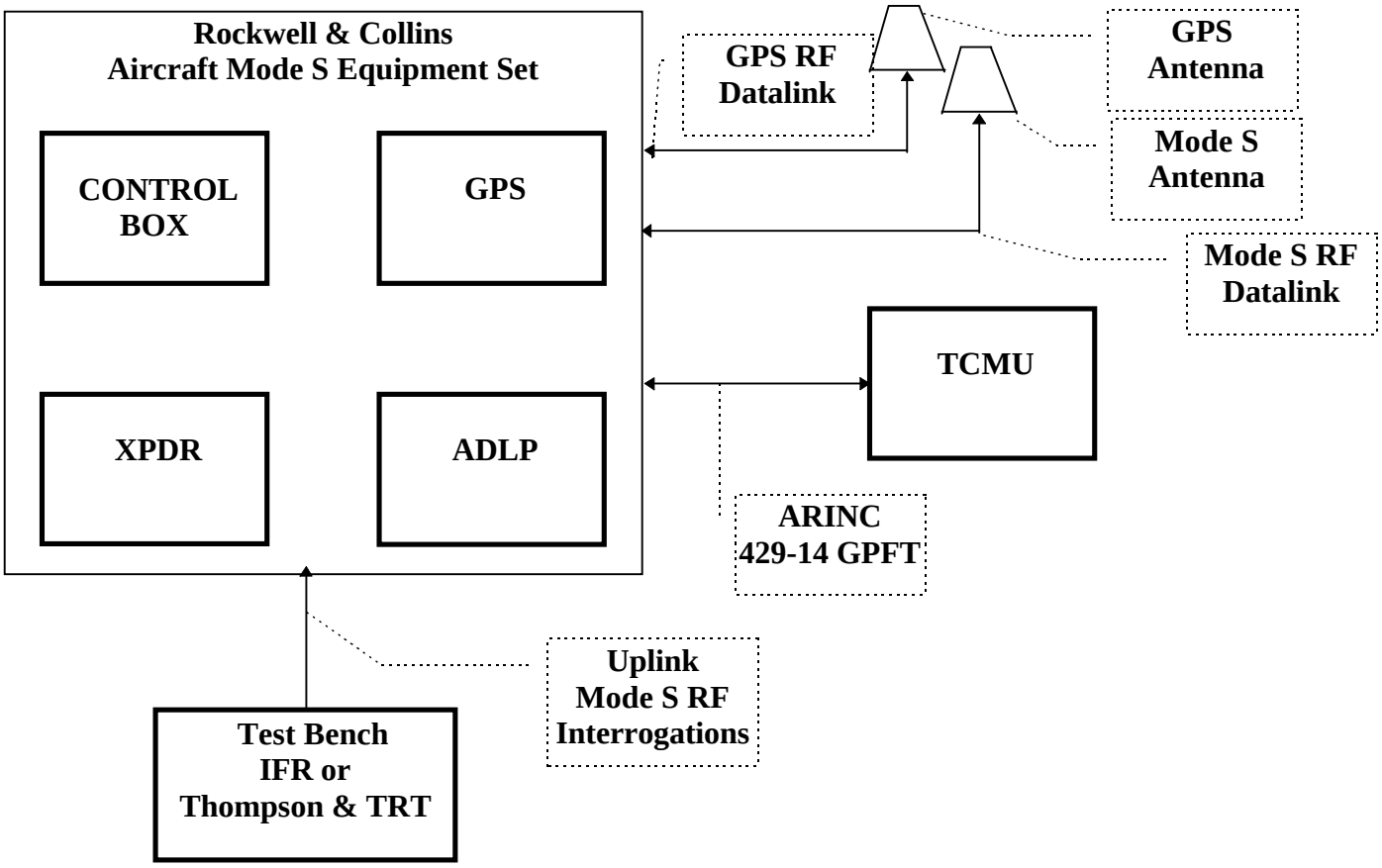


Figure no. 4 TCMU Simulation environment

With the purpose of doing an evaluation of the Rockwell & Collins Mode S aircraft equipment set, several tests were made using the simulation environment shown above. This equipment set is composed of a Mode S transponder (XPDR), a Global Positioning System (GPS), an Aircraft Data Link Processor (ADLP) and a control box. The major interests of these tests were to establish a data link able to transport GICB, MSP and broadcast messages for uplink and downlink using ARINC 429-14 GPFT between the TCMU and this equipment set.

9. References

EEC Note No. 17/94 - ADVANCED PC ARINC CARD - VERSION 2
by H.P. ENGLMEIER

ARINC Document - MARK 3 Air Traffic Control Transponder (ATCRBS / Mode S)

ARINC Characteristic 718-4, 15.12.1989

ICAO Aeronautical Telecommunications (Annex 10)

Appendix 1

1. GICB Message for the register number 40.

Bit 1 Status bit of flight path angle, label 322, range + - 180°, 10 bit, resolution 0,18° .

Bit 2 Sign bit
Bit 3..12 Data = 190°

Bit N° 1 12

1	1	1	1	1	0	1	1	0	0	0	0

Bit 13 Status bit of flight path acceleration, label 323, range 4 g, 12 bit, resolution 0.001g

Bit 14 Sign bit , always 0
Bit 15..26 Data = 0,016 g

Bit N° 13 26

1	0	0	0	0	0	0	0	0	1	0	0	0	0

Bit 27 Status bit of corrected angle of attack, label 241, range + - 180°, 12 bit, resolution 0,044°

Bit 28 Sign bit
Bit 29..40 Data = 10°

Bit N° 27 40

1	0	0	0	0	0	1	1	1	0	0	1	0	0

Bit 41 Status bit of barometric corrected altitude, label 204, range 131072 ft, 14 bit, resolution 8 ft

Bit 42 Sign bit, always 0
Bit 43..56 Data = 34000 ft

Bit N° 41 56

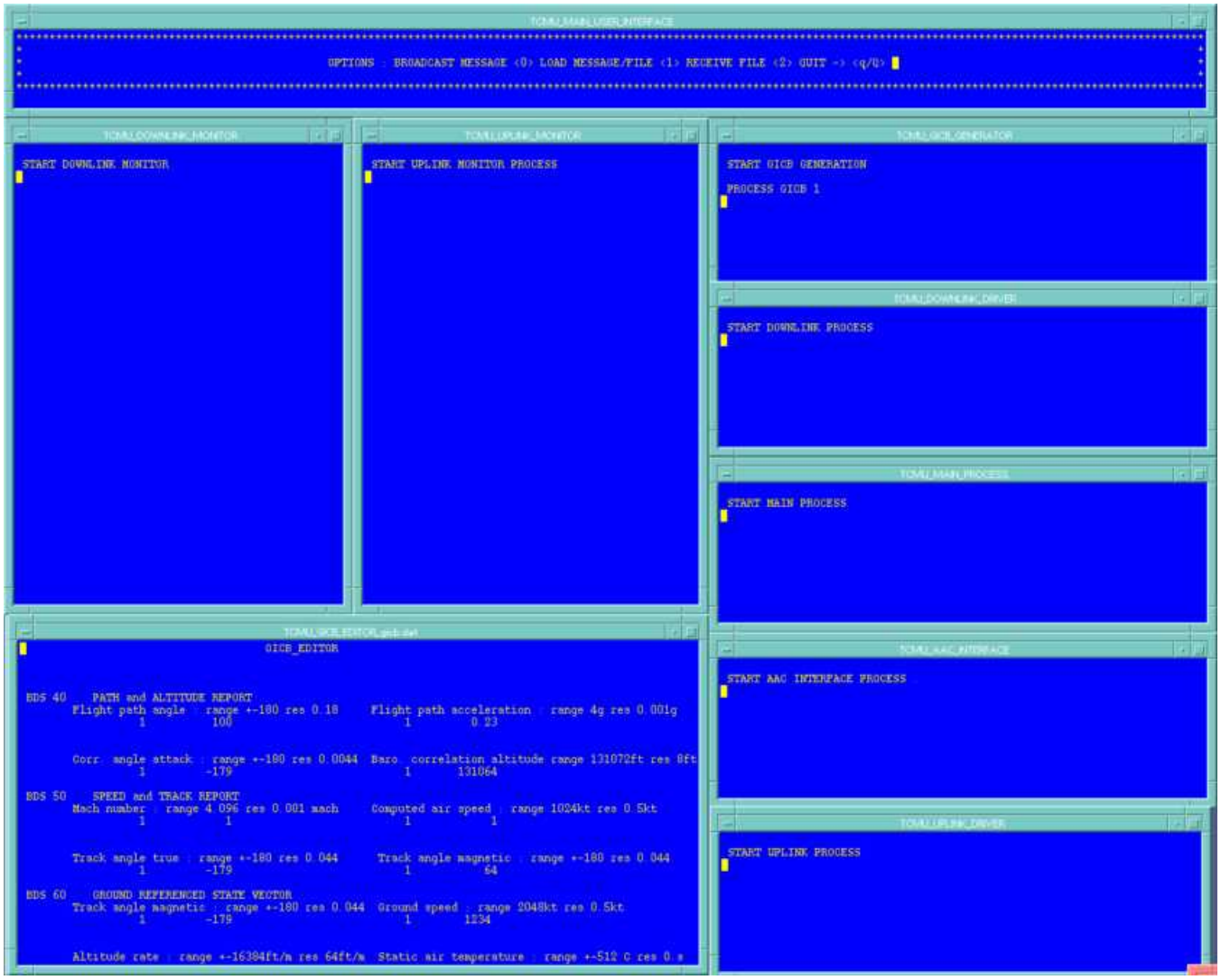
1	0	0	1	0	0	0	0	1	0	0	1	1	0	1	0

The GICB message will be :

10	GICB message type
40	Register number
c3	GICB data = c3980420e4909a
98	
04	
20	
e4	
90	
9a	

All numbers are in hexadecimal notation.

xterm
E.E.C June 1996 by Joao M. M. Martins
Enter your GICB file name :


TCMU_MAIN_USER_INTERFACE
OPTIONS : BROADCAST MESSAGE <0> LOAD MESSAGE/FILE <1> RECEIVE FILE <2> QUIT -> <q/Q>
TCMU_DOWNLINK_MONITOR
START DOWNLINK MONITOR
TCMU_UPLINK_MONITOR
START UPLINK MONITOR PROCESS
TCMU_GICB_GENERATOR
START GICB GENERATION
PROCESS GICB 1
TCMU_DOWNLINK_DRIVER
START DOWNLINK PROCESS
TCMU_MAIN_PROCESS
START MAIN PROCESS
TCMU_GICB_EDITOR_grab.dat
GICB_EDITOR
BDS 40 PATH and ALTITUDE REPORT
Flight path angle : range +-180 res 0.18
1 100
Flight path acceleration : range 4g res 0.001g
1 0.23
Corr. angle attack : range +-180 res 0.0044
1 -179
Baro correlation altitude range 131072ft res 0ft
1 131064
BDS 50 SPEED and TRACK REPORT
Mach number : range 4.096 res 0.001 mach
1 1
Computed air speed : range 1024kt res 0.5kt
1 1
Track angle true : range +-180 res 0.044
1 -179
Track angle magnetic : range +-180 res 0.044
1 64
BDS 60 GROUND REFERENCED STATE VECTOR
Track angle magnetic : range +-180 res 0.044
1 -179
Ground speed : range 2048kt res 0.5kt
1 1234
Altitude rate : range +-16384ft/m res 64ft/m
Static air temperature : range +-512 C res 0.5
TCMU_AAC_INTERFACE
START AAC INTERFACE PROCESS
TCMU_UPLINK_DRIVER
START UPLINK PROCESS